Transforming logistics and smart ports in Europe

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The EU-funded 5G-LOGINNOV project is creating new opportunities for LOGistics value chain INNOVation by harnessing the power of 5G in the ports domain. This is all thanks to an innovative framework for integrating and validating connected and automated mobility (CAM) technologies related to Industry 4.0. 5G-LOGINNOV supports the port application case by implementing 5G technological blocks. A new generation of 5G terminals for CAM, new types of Internet of Things (IoT) 5G devices, data analytics, next-generation traffic management, and emerging 5G networks are grouped to allow city ports to handle current and future capacity and traffic, increase efficiency, and manage environmental challenges.

Innovation in Living Labs

As a catalyst for market opportunities built on 5G core technologies in the logistics domain, 5G-LOGINNOV is set to be a pillar of economic development and business innovation, particularly by promoting local high-tech SMEs and start-ups. The project's three Living Labs – in the European ports of Hamburg, Athens and Koper – will be the facilitators and ambassadors opening up doors for innovation in ports, covering both deep sea harbours in the mega vessel era (Hamburg, Athens) and medium-sized seaports with limited investment funds for 5G (Koper).

5G-LOGINNOV is trialling 11 clusters of use cases beyond technology readiness level 7 (system prototype demonstration in operational environment) in its three Living Labs based on 5G technological blocks, including the Management and Network Orchestration platform (MANO), Device Management Platform Ecosystem, Optimal Selection of Yard Trucks, Optimal Surveillance Cameras and Video Analytics, Automation for Ports, Port Control, Logistics and Remote Automation, Mission Critical Communications in Ports, Predictive Maintenance, Floating Truck & Emission Data, 5G GLOSA & Automated Truck Platooning (ATP), Dynamic Control Loop for Environment Sensitive Traffic Management Actions (DCET).

Trialling future reality

Strict security of the cloud infrastructure system is a crucial requirement for all ports. Smart routing of the port-related network services and applications traffic directly to the port operations support systems is made possible by extending the Mobile Network Operator (MNO) infrastructure with Multi-access Edge Computing (MEC) capabilities.

In addition to commercial MNO services, the private 5G mobile network with dedicated cloud infrastructure is tailored to the needs of port operations and targeted applications.

In 5G-LOGINNOV, a 5G edge processing node is implemented to support ship-to-shore (STS) crane operations. Massive 4K (uplink/downlink) live video transmissions towards the (far-)edge processing nodes serve as the input for machine learning (ML) models delivering the envisioned services. Such uplink-data-intensive applications call for enhanced capacity that cannot be served with legacy LTE networks. Hence, the Enhanced Mobile Broadband (eMBB) service of 5G technology is needed.

Making port operations safer

Low-latency transmission and eMBB capabilities of 5G are used in combination with artificial intelligence (AI) to set up a rapid alert delivery system for collision avoidance between yard trucks and people. A 4K camera is mounted on the yard truck, and a 5G modem is employed to establish cellular communication within the port. The camera is oriented to the driver's

potential blind spot and transmits 4K video streams (uplink) to a GPU-enabled edge computing device in real time. An AI-enabled service deployed in the edge processing node receives and processes the video feed. If a person is detected, the driver is alerted with live annotated 4K video streams (downlink) in order to increase their situational awareness.

Frequent incidents involving boom, gantry or stack collisions, along with the presence of stevedoring personnel in port areas, generate considerable risks. To minimise the risk of serious bodily injuries, 5G-IoT devices installed in selected areas, equipped with a high-resolution camera, perform video analytics tasks locally. Using innovative ML techniques, with the help of large 4K surveillance video streams facilitated by 5G eMBB service, quick and accurate human presence detection is made possible. This use case increases safety measures in the employee workplace, opening up opportunities to optimise the use of human resources in different port operations, e.g., by reducing the patrol frequency at the risk areas.

Looking into the future

A key concern of almost any port is storing and managing bulky assets, such as spare/repair parts, especially when operating close to maximum annual capacity. In 5G-LOGINNOV, end-to-end asset performance monitoring in all phases of daily port operations is enabled by telemetry data transmitted over 5G from several data sources on board yard trucks.

The resulting predictive maintenance algorithm is used to anticipate possible breakdowns, thereby reducing downtime for repairs, increasing the service life of yard vehicles, and optimising the stock of spare parts and the overall operational efficiency. The predictive maintenance tool captures historical and recent status data for the assets in question (schedule of purchases, storage of parts, proactive maintenance), for the ML algorithm, with 5G technology providing a flexible, reliable and predictable environment to remotely keep track of the connected assets on a real-time basis.

Industrial cameras installed on operating port machinery (STS cranes) capture and transfer Ultra-High Definition (UHD) streams to the cloud-based video analytics system. Container markers are identified, and structural damage is detected by using advanced AI/ML-based video processing techniques.

To boost overall port operation, coordination with inbound external trucks is also foreseen in order to expedite container handover operations (transition of containers from external to internal trucks and vice versa), provide an estimated time of arrivals/departures, etc.

Thanks to the new advanced capabilities of 5G relating to wireless connectivity and Core Network agility, 5G-LOGINNOV ports will not only significantly optimise their operations but also minimise their environmental footprint on the city and the disturbance to the local population.

5G-LOGINNOV is already looking ahead to trialling B5G (beyond 5G) and 6G. Although they are still at an early stage of development, some B5G/6G candidate technologies – such as AI-Enabled Networks, Massive Multiple Input Multiple Output (MIMO), Dynamic Spectrum Access, Network Slicing, Edge Computing, Integrated Satellite-Terrestrial Networks, Quantum Communication, Massive IoT Connectivity, Augmented Reality (AR) and Virtual Reality (VR), Energy-Efficient Communication and Environmental Monitoring – could play a strong role in extending the impact of 5G-LOGINNOV.

Market approach

The 5G-LOGINNOV project has adopted a comprehensive market approach to ensure the effective take-up of its innovative solutions. The project emphasises collaborative business models and future common initiatives by recognising the importance of collaboration among stakeholders for advancing innovation and data sharing.

To this end, 5G-LOGINNOV has adopted a business modelling methodology called GUEST to assess stakeholder requirements, challenges, and opportunities, followed by designing specific business solutions through the Solution Canvas.

In such a way, the 5G-LOGINNOV project assumes a significant role as an innovator and incubator for start-ups in the field of 5G technology, particularly related to improving logistics and transportation operations in ports.
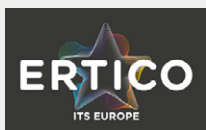
Save the World-Save the Planet

Last year, the team working on 5G and Transport & Logistics projects, such as 5G-LOGINNOV and FENIX, got ISO standard approval. Based on this standard (17748-1 Energy-based green ITS services on nomadic & mobile devices for smart city mobility applications – Part 1: General information and use cases definition), the ISO/Technical Committee 204 has decided to cover this important topic and set-up a new sub-working group (SWG) as part of its working group (WG) 17 on Nomadic Devices in ITS Systems.

This new SWG 17.2 Save the World-Save the Planet is developing a series of international standards which define energy-based green ITS services providing urban and smart city mobility applications on nomadic & mobile devices by measuring energy consumption and CO_2 emissions and providing information to users on energy capacity in the transportation sectors. This new ISO standard supports the European Green Deal. ∎